3V/35mW dual power amplifier

BA5204F

The BA5204F is a dual-channel power amplifier designed for 3V stereo headphone tape players. There is almost no "pop" sound generated when the power is switched on and off, so this IC is ideal for headphone applications. Input coupling capacitors are not required, and only one filter capacitor is needed which helps reduce set size. In addition to operating off low voltage, the IC has low distortion, making it suitable for Hi-Fi applications. The circuit can operate down to 1.5V, and has excellent ripple rejection, so it is not adversely influenced by the motor or tape transport systems.

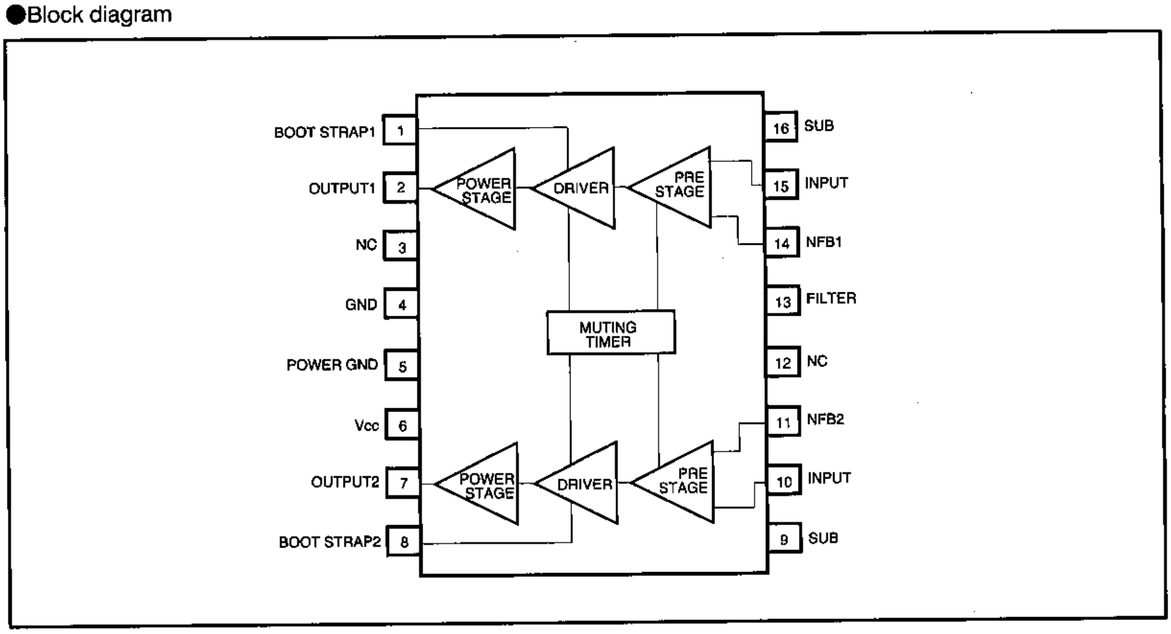
● Applications

3V compact cassette headphone stereos players, micro cassette players, and FM stereo radios.

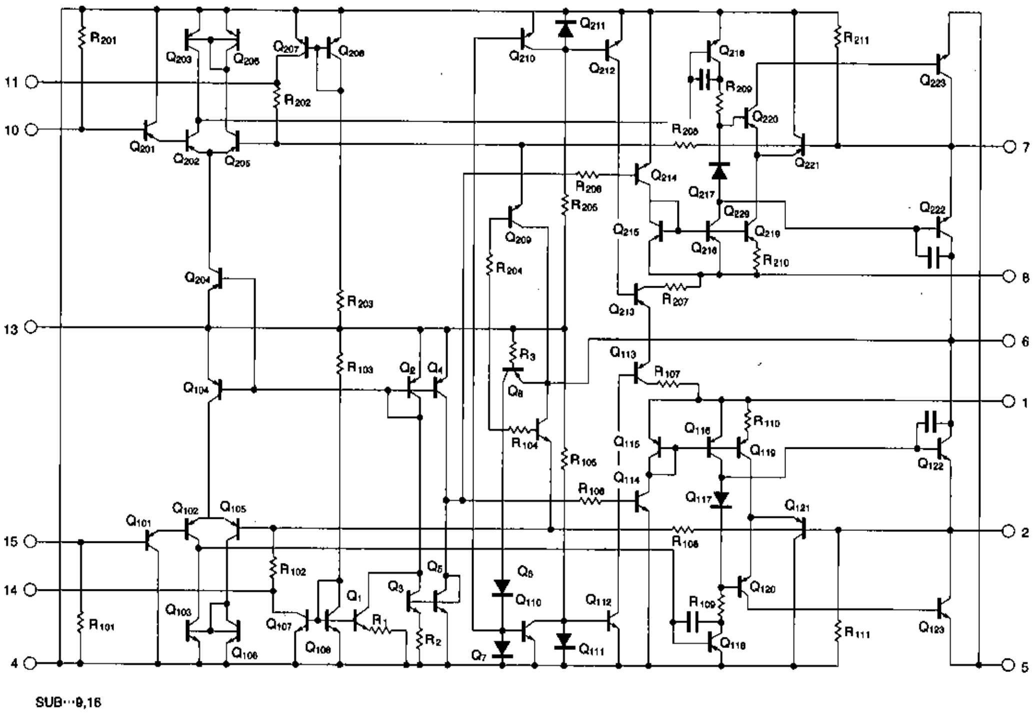
● Features

1) Rated output of 35mW (RL = 32Ω) off a 3V power supply.
2) Low "pop" noise when power is switched on and off.
3) Low quiescent current (13mA).
4) Excellent ripple rejection (38dB).
5) Begins operating at 1.5V.
6) Low distortion (0.05% at Po = 5mW).
7) Good voltage gain balance between channels.
8) Good channel separation (60dB typ.).
9) Input coupling capacitors not required.
10) Symmetrical pin layout facilitates PCB design.

● Block diagram



●Internal circuit diagram



●Circuit explanation (refer to the Internal Circuit diagram)

(1) Preamplifier Stage

The preamplifier is comprised of the level-shift transistor Q_{101}, a differential amplifier (Q_{102} and Q_{105}), and the active load (Q_{103} and Q_{106}). The input is a PNP transistor that does not require a coupling capacitor.

(2) Pre-drive stage

Q_{118} is the pre-drive transistor. Q_{122} and Q_{120} form the load.

(3) Power stage

Comprised of phase-inverting transistor Q_{120}, and power transistors Q_{122} and Q_{123}.

(4) Idling current setting circuit

The idling current is controlled so that the difference between the V_{BE} of the power transistor Q_{122} and the V_{BE} of the phase-inverting transistor Q_{120} is the same as the difference between the V_F of the constant-voltage diode Q_{117} and the V_{BE} of Q_{121}.

(5) Negative-feedback circuit

The closed-circuit gain with negative feedback is determined by R_{108}, R_{102}, and the value of the resistor connected to the NFB pin. Part of the gain setting resistance is on the chip (R_{102}) to reduce variance between components.

(6) "Pop" noise elimination circuit

The IC has an internal timing circuit (with switch for operation) to reduce the "pop" noise that occurs when power is applied.

●Absolute maximum ratings (Ta = 25℃)

Parameter	Symbol	Limits	Unit
Supply voltage	Vcc	6.0	V
Power dissipation	Pd	500*	mW
Operating temperature	Topr	−25~75	℃
Storage temperature	Tstg	−55~125	℃
Junction temperature	Tj	125	℃

* Reduced by 5.0mW for each increase in Ta of 1°C over 25°C
(when mounted on a 70mm x 70mm x 1.6mm glass epoxy PCB).

●Electrical characteristics (unless otherwise specified Ta = 25℃, Vcc = 3V, f= 1kHz and RL = 32Ω)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Quiescent circuit current	I_Q	—	13	20	mA	V_{IN}=0Vrms
Closed-circuit voltage gain	G_{VC}	32	35	38	dB	V_{IN}=−45dBm
Rated output	P_{OUT}	23	35	—	mW	THD=10%
Distortion	THD	—	0.05	0.3	%	P_O=5mW
Output noise voltage	V_{NO}	—	80	200	μVrms	R_g=0Ω、G_{VC}=35dB B.P.F.20Hz~20kHz
Input resistance	R_{IN}	2.0	30	—	kΩ	—
Ripple rejection ratio	RR	28	38	—	dB	V_{RR}=−20dBm、f=100Hz、R_g=0Ω
Operation start voltage	V_S	—	1.5	1.8	V	—

●Measurement circuit

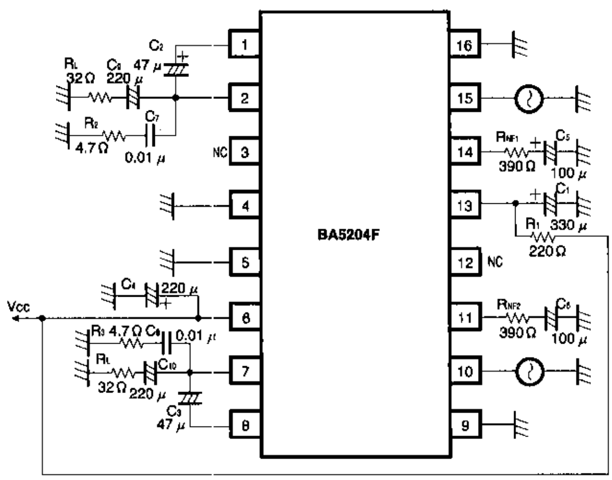
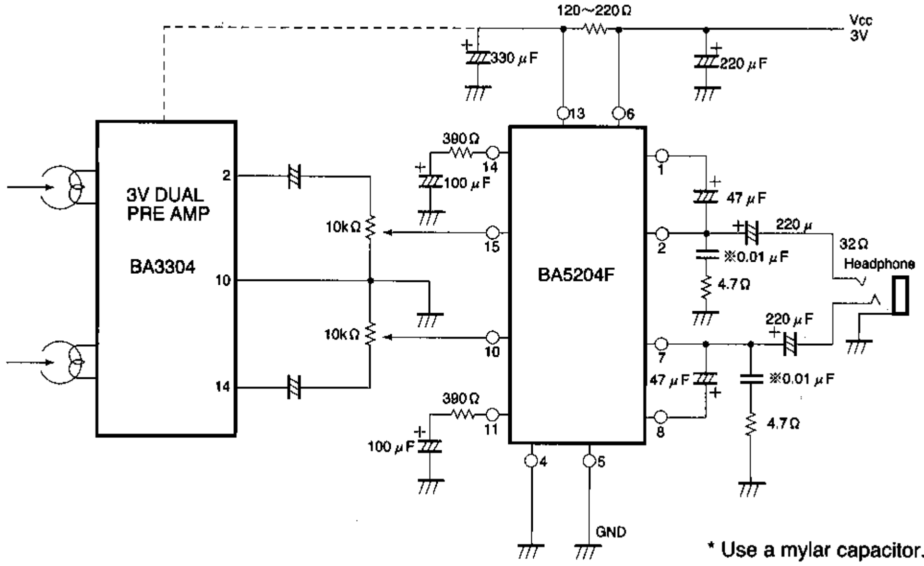


Fig. 1

●Application example



* Use a mylar capacitor.

Fig. 2 Application example circuit for a 3V stereo compact-cassette player.

●External components (Fig. 15)

C_1 : filter capacitor

The recommended value is 330 µF. If this is reduced too much, the ripple rejection ratio will drop. This capacitor also sets the muting time when power is applied. Reduce the value of this capacitor if you wish to shorten the startup time. On the other hand, if you wish to reduce the "pop" noise further, increase the value of this capacitor to lengthen the startup time.

C_2 and C_3 : bootstrap capacitors

The recommended value is 47 µF. If the capacitance is too small, the IC will not be able to produce its rated power in the bass region and distortion will increase.

C_5 and C_6 : feedback circuit DC blocking capacitors

These capacitors and RNF set the bass cutoff frequency.

$$ch_1 \cdots\cdots f_{LC1} = \frac{1}{2\pi \cdot C_5 \cdot (R_{NF1} + R_{102})}$$

$$ch_2 \cdots\cdots f_{LC2} = \frac{1}{2\pi \cdot C_6 \cdot (R_{NF2} + R_{202})}$$

R_{NF1} and R_{NF2} determine the amount of feedback for the feedback circuit. These resistors determine the closed-circuit voltage gain (G_{VC}).

C_7 and C_8 : depending on the PCB design, and output circuit wiring, feedback may be applied to the IC's internal circuits and cause high-frequency oscillation. These capacitors prevent this from happening. They also increase the amount of design freedom with regard to the output wiring and PCB artwork. Design the PCB so that the length of the wiring from ch1 and ch2 to capacitors and from the capacitors to GND is as short as possible. Mylar capacitors of about 0.01 µF are appropriate for this application, although active capacitors may also be used. The residual impedance and resonant frequency will differ depending on the type of capacitor and therefore have some influence on the effectiveness.

C_9 and C_{10} : output coupling capacitors

The recommended value is 220 µF. If the capacitance is too small, the IC will not be able to produce its rated power in the treble region and distortion will increase.

● Electrical characteristics curves

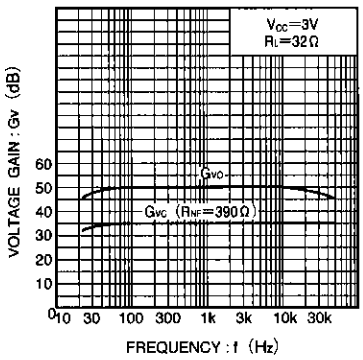


Fig. 3 Voltage gain vs. frequency

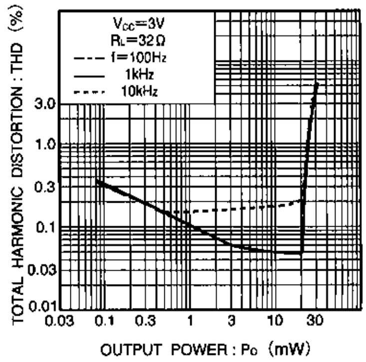


Fig. 4 Distortion vs. output power

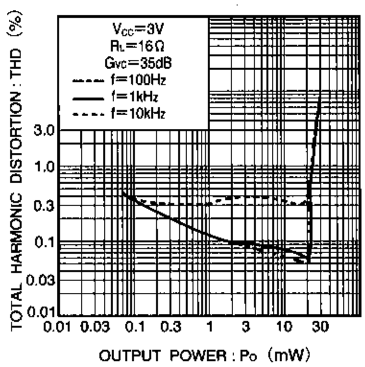


Fig. 5 Distortion vs. output power

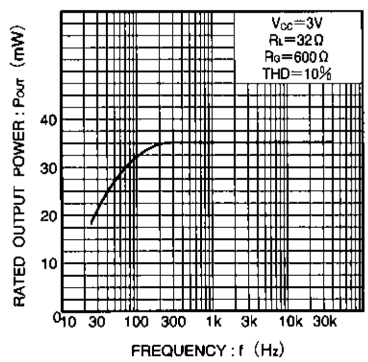


Fig. 6 Rated output power vs. frequency

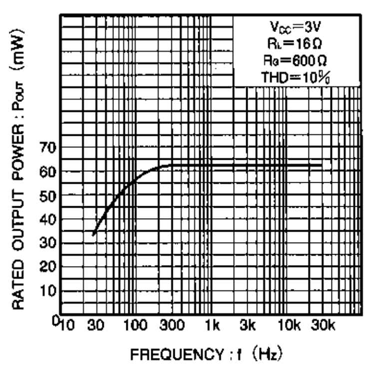


Fig. 7 Rated output power vs. frequency

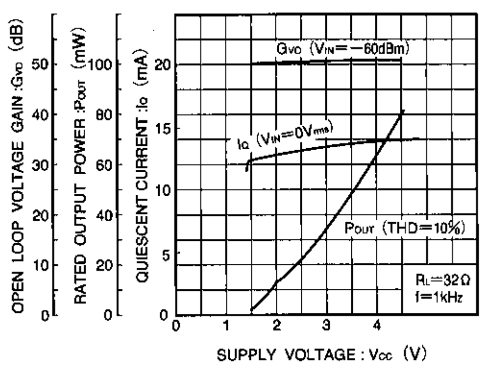


Fig. 8 Open-loop voltage gain/quiescent current/rated output power vs. supply voltage

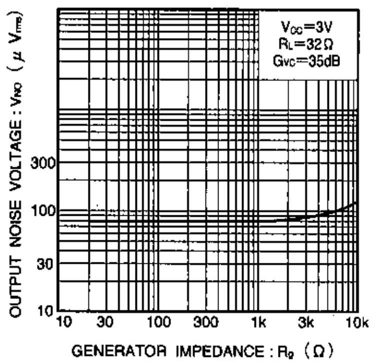


Fig. 9 Output noise voltage vs. signal source impedance

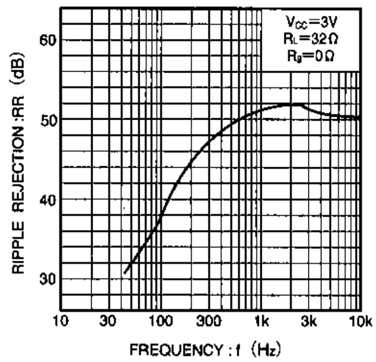


Fig. 10 Ripple rejection ratio vs. frequency

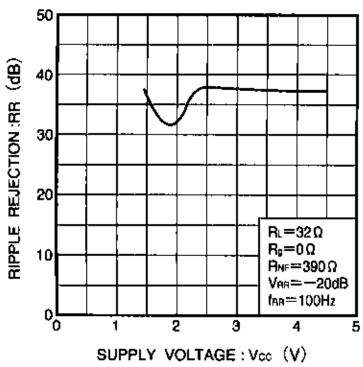


Fig. 11 Ripple rejection ratio vs. supply voltage

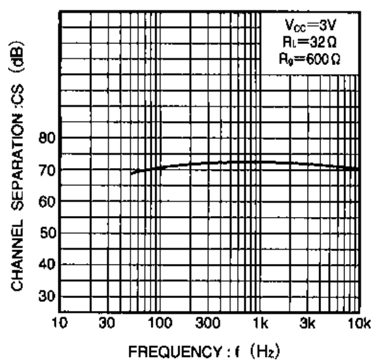


Fig. 12 Channel separation vs. frequency

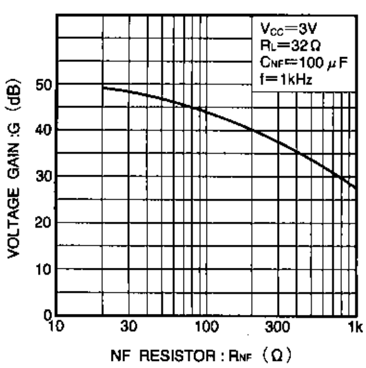


Fig. 13 Voltage gain vs. feedback resistor value

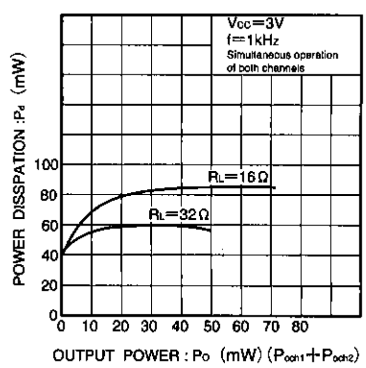


Fig. 14 Power dissipation vs. output power

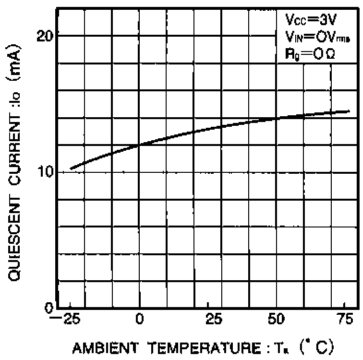


Fig. 15 Quiescent current vs. ambient temperature

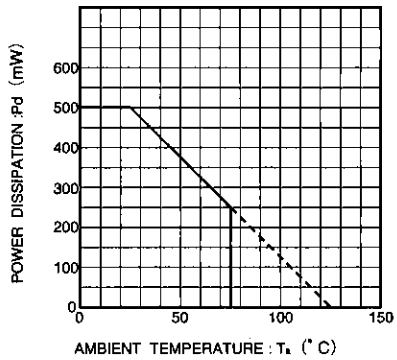
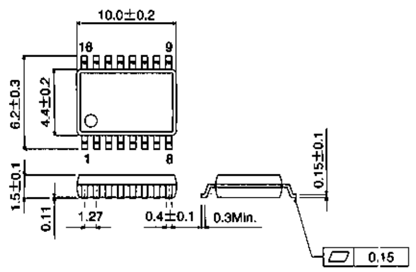


Fig. 16 Allowed power dissipation vs. ambient temperature

●External dimensions (Unit: mm)



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